



# **Update on Groundwater-Level Elevations in the Denver Basin Bedrock Aquifers of Elbert County, Colorado, 2021-2024**

**Presentation to the Elbert County Board of County  
Commissioners**

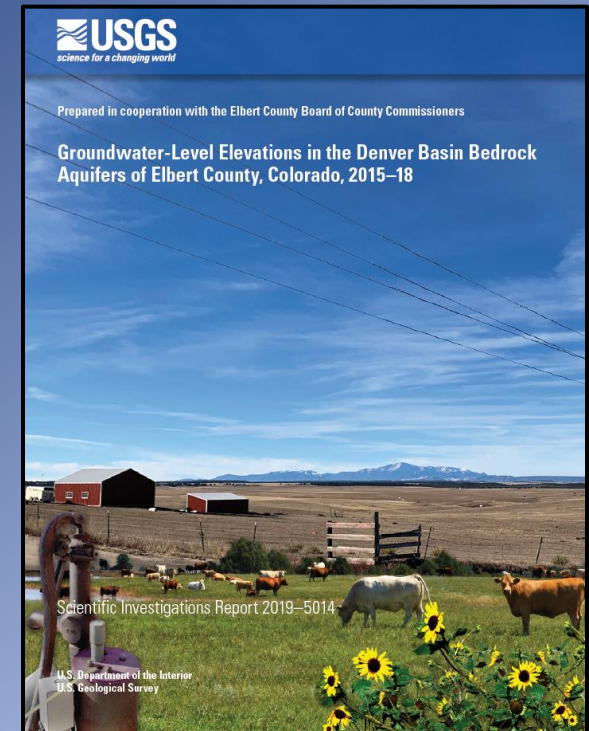
**11 July 2022**

*Cory Russell & Kelli Palko*

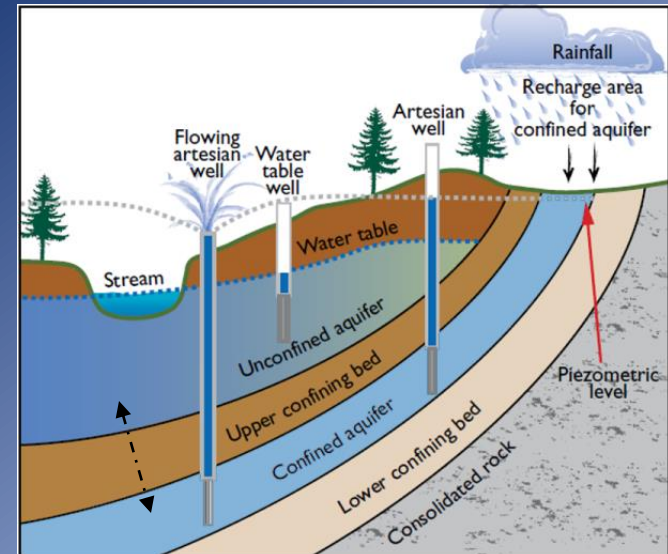
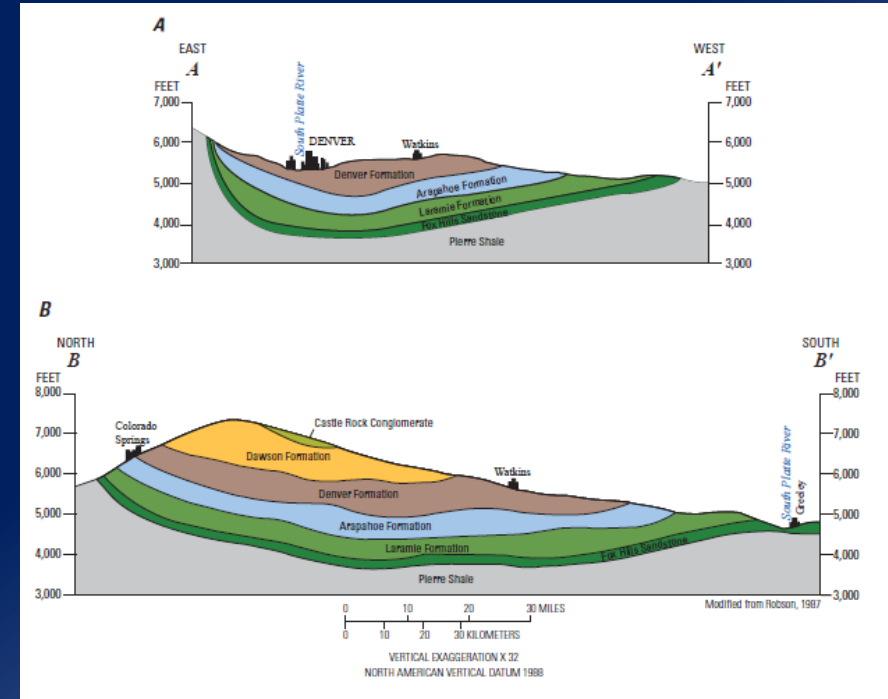
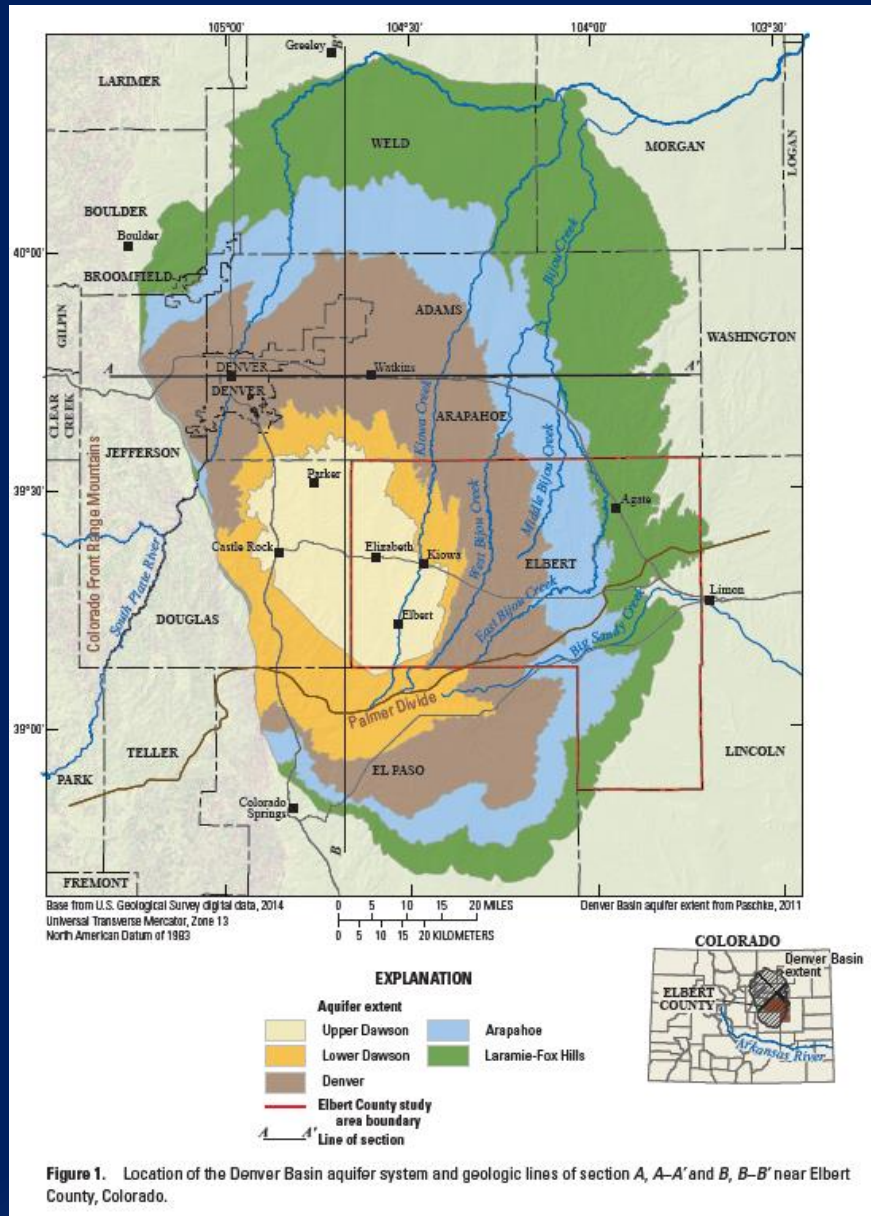
*USGS Colorado Water Science Center*

# Outline-

- Overview of the Denver Basin bedrock aquifers
- Measurement methods
- Well selection
- New wells selection
- Measurement general summary
- Analysis methods used for 2015-2018 data
- Future work, questions, and discussion



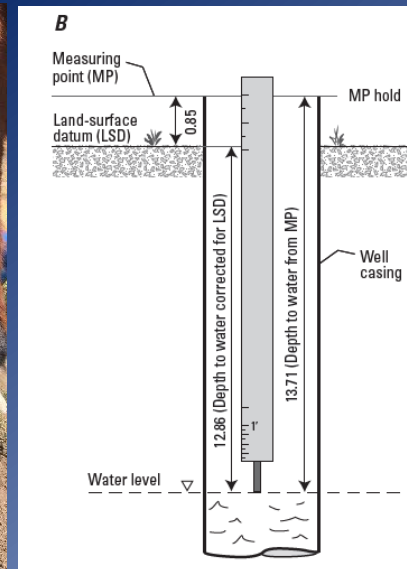
# Denver Basin bedrock aquifers



**Figure 1.** Location of the Denver Basin aquifer system and geologic lines of section A, A-A' and B, B-B' near Elbert County, Colorado.

# Measurement methods

- Discrete depth-to-water measurements collected with calibrated steel tape or electronic tape
  - 2 manual measurements for validation and assess well condition
- Continuous depth-to-water measurements calibrated with discrete measurement
- Groundwater elevation calculated from depth-to-water



$$\text{Groundwater-level elevation} = \text{LSD} - \text{Water level below LSD} \quad (1)$$

where

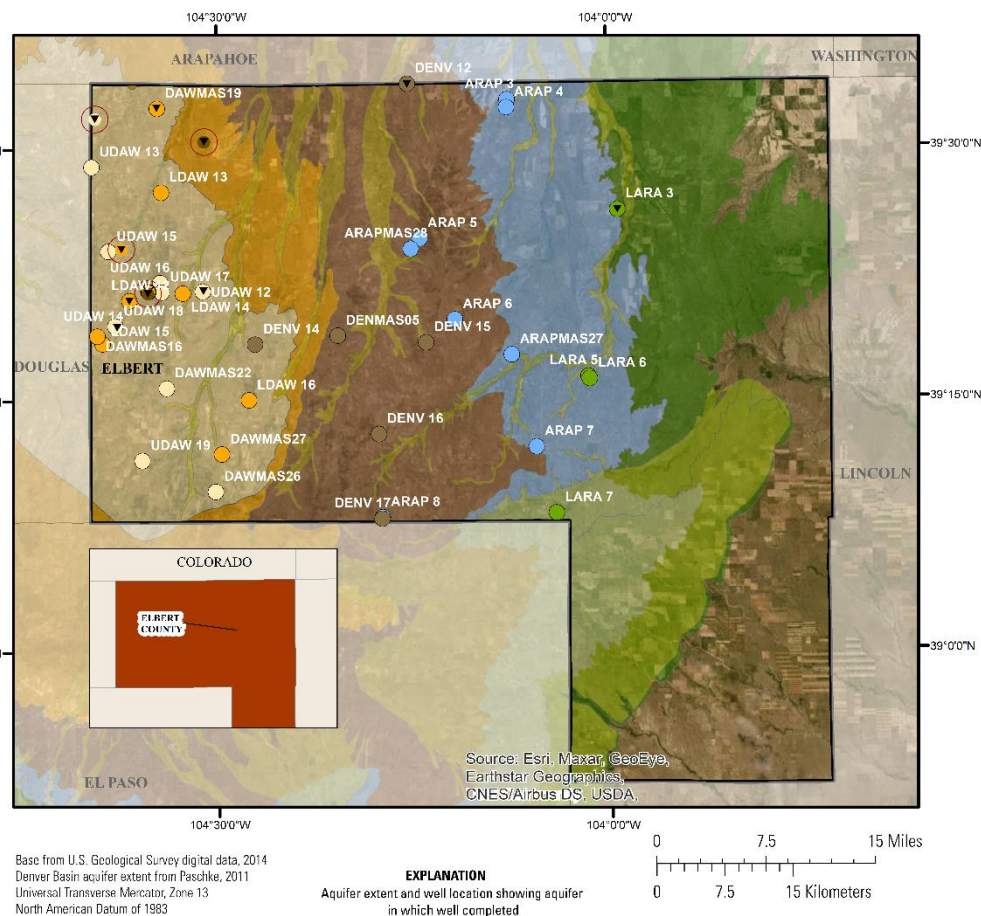
*Groundwater-level elevation*  
*LSD*

*Water level below LSD*

is groundwater-level elevation, in ft above NAVD 88;  
is land-surface datum, in ft above NAVD 88; and  
is measured depth, in ft, to groundwater below land-surface datum.



# Well selection



## Denver Basin bedrock aquifer extents

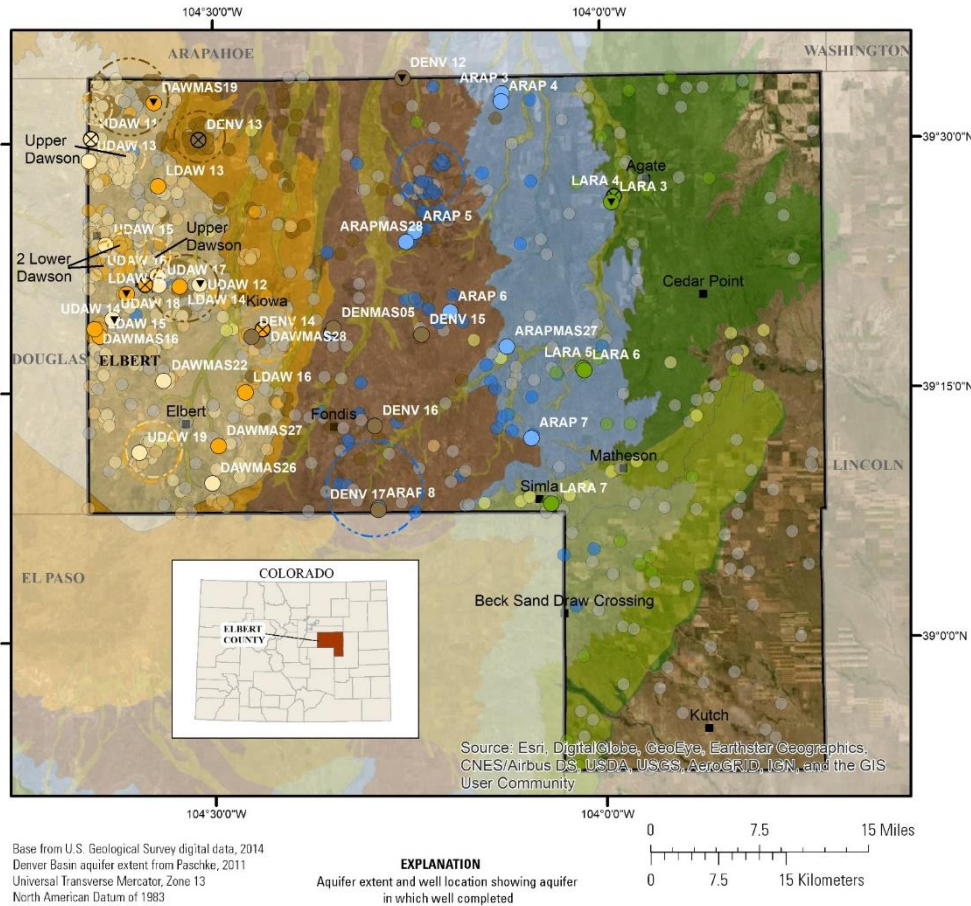
- Alluvial deposits aquifer outcrop extent
- Upper Dawson aquifer outcrop extent
- Lower Dawson aquifer outcrop extent
- Denver aquifer outcrop extent
- Arapahoe aquifer outcrop extent
- Laramie-Fox Hills aquifer outcrop extent

## Well and aquifer of completion

- Well in Upper Dawson aquifer
- Well in Lower Dawson aquifer
- Well in Denver aquifer
- Well in Arapahoe aquifer
- Well in Laramie Fox Hills aquifer

- 40 wells
  - 11 Upper Dawson
  - 9 Lower Dawson
  - 8 Denver
  - 8 Arapahoe
  - 4 Laramie-Fox Hills
  
- 10 continuous WL
  - 3 Upper Dawson
  - 3 Lower Dawson
  - 3 Denver
  - 1 Laramie-Fox Hills

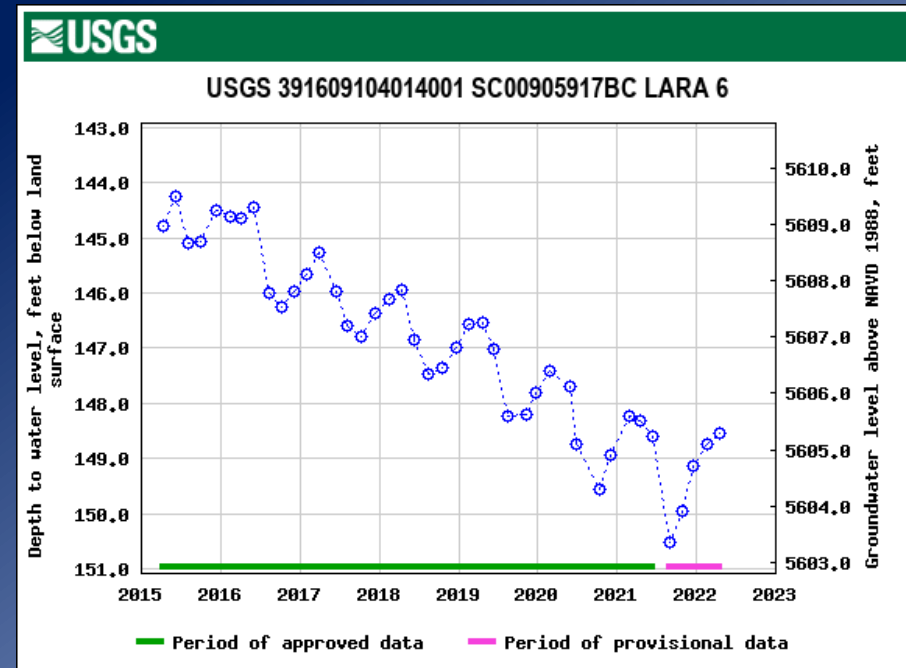
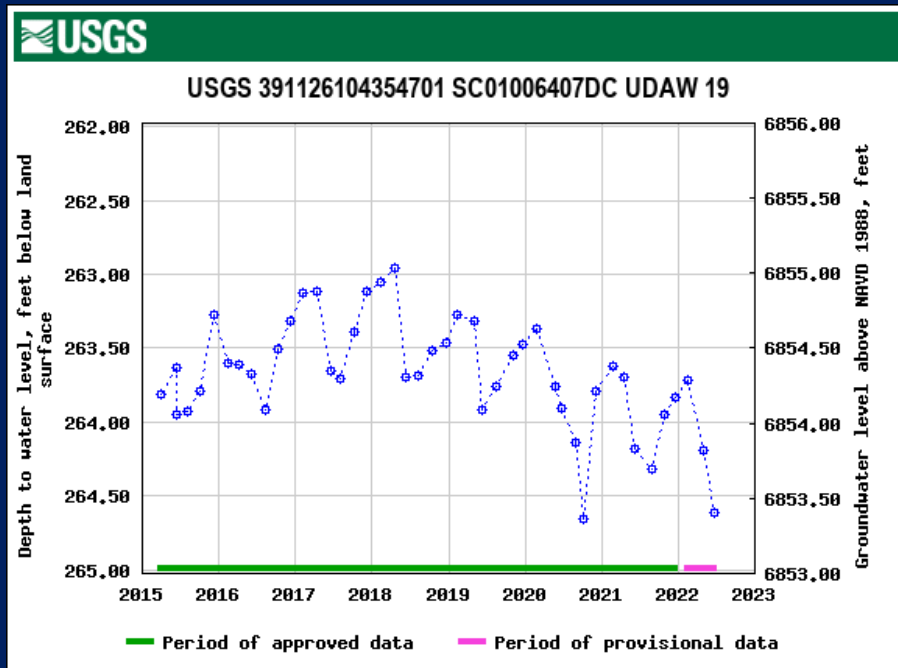
# New Well selection



- Prioritize the eastern section of Elbert County
  - More recent development
  - More available options

# Measurement general summary

- Month of highest GW Elevation
  - Late winter to early spring
- Month of lowest GW Elevation
  - Summer and fall





# Analysis methods

- 2015-2018 Trend analysis – linear regression and linear regression with seasonality terms

- $p\text{-value} \leq 0.10$

- $R^2 \geq 0.40$

- $\beta_1$

- Relative difference and potentiometric surface

- April 2015 – April 2018

- Ordinary kriging in ArcGIS



$$Y = \beta_0 + (\beta_1 \times T)$$

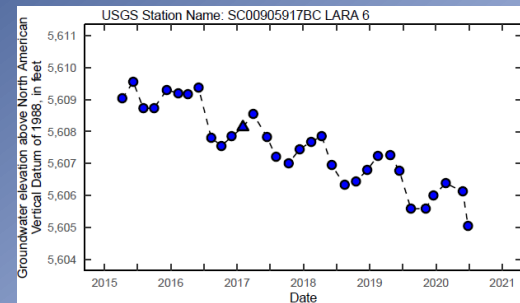
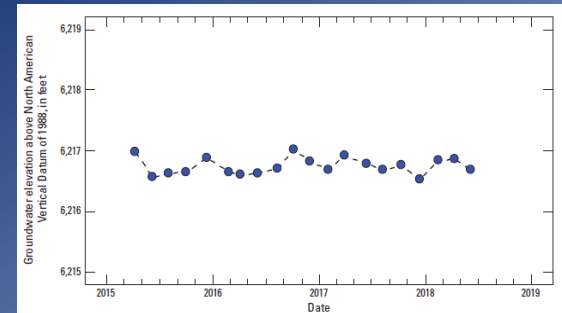
where

$Y$  is groundwater-level elevation, in ft above NAVD 88;  
 $T$  is time, in decimal years;  
 $\beta_0$  is intercept, in ft above NAVD 88; and  
 $\beta_1$  is slope coefficient of  $T$ , in ft/year.

$$Y = \beta_0 + (\beta_1 \times T) + (\beta_2 \times \sin(2\pi T)) + (\beta_3 \times \cos(2\pi T))$$

where

$Y$  is groundwater-level elevation, in ft above NAVD 88;  
 $T$  is time, in decimal years;  
 $\beta_0$  is intercept, in ft above NAVD 88;  
 $\beta_1$  is slope coefficient of  $T$ , in ft/year;  
 $\beta_2$  is coefficient of seasonal sine term, years; and  
 $\beta_3$  is coefficient of seasonal cosine term, in years.





# Anticipated Report Analyses

- Groundwater-elevation trend maps
- Potentiometric surface maps

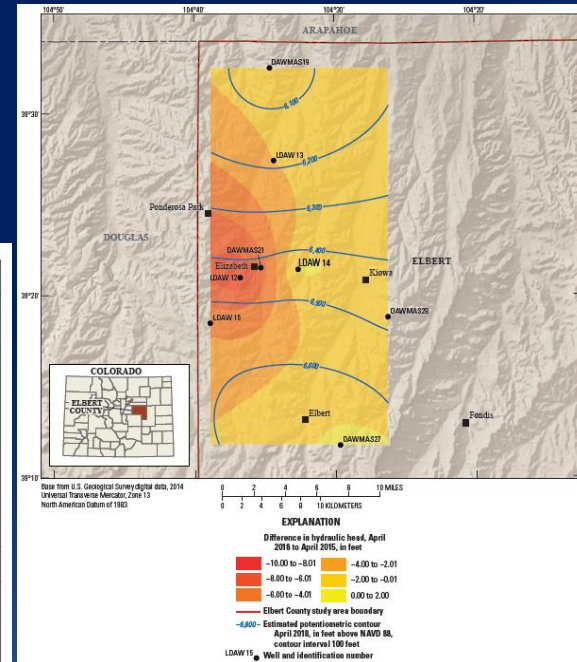
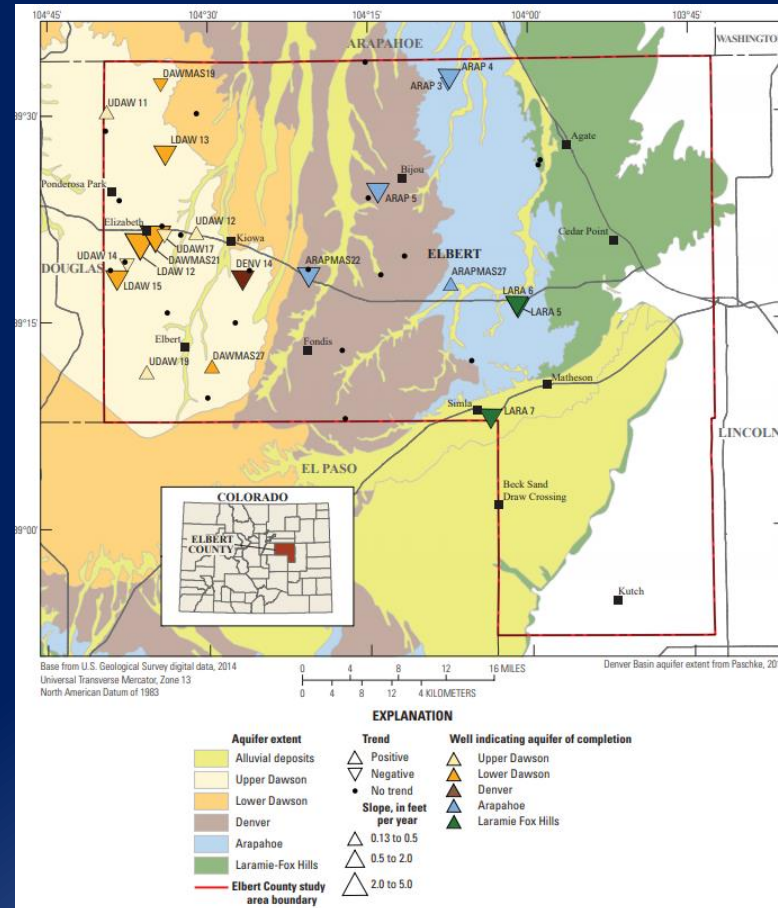
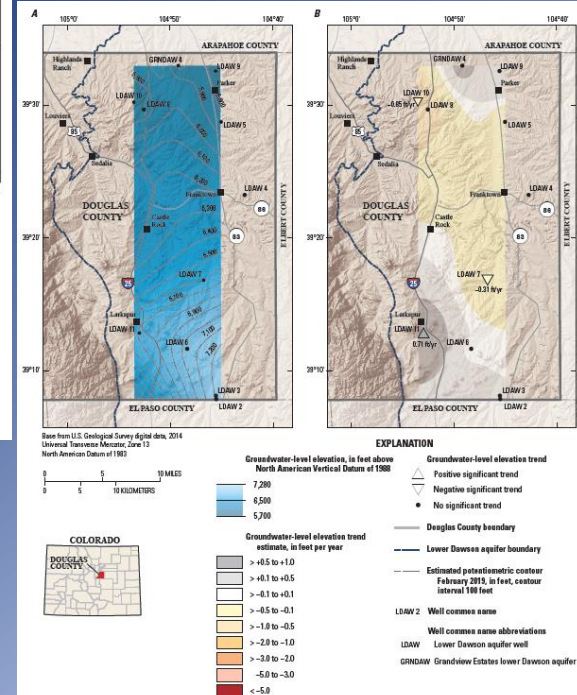


Figure 8. Estimated potentiometric surface of the lower Dawson aquifer in April 2018 and change in hydraulic head between April 2015 and April 2018, western Elbert County, Colorado.



# Future Work, Questions, and Discussion

- FY2021-23: Continuation of data collection, and annual presentations to Elbert County
- In FY2023, initial steps of USGS SIR preparation, which will present summaries and trend analyses of the data from 2015 through 2023
- SIR to be published by the end of FY2024
- Continuation of work with a new proposal in FY2024

Workplan Element	FY2022				FY2023				FY2024			
	Oct '21	Jan '22	Apr '22	Jul '22	Oct '22	Jan '23	Apr '23	Jul '23	Oct '23	Jan '24	Apr '24	Jul '24
Task 1 (Data collection and management)	X	X	X	X	X	X	X	X	X			
Task 2 (Report preparation)							X	X	X	X	X	



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